Atomic Physics:

- 1897 → J.J. Thomson
  discovers that electrons are negatively charged

- 1900s → Robert Millikan
  "oil drop experiment"
  determined the charge of an e⁻

- Blackbody Radiation
  - Curve fit by Max Planck

$$E = hf$$

↓ energy; ↓ constant = $6.63E-34\ J$ = $4.14E-15\ eV \cdot s$; ↳ frequency

- Energy had to exist in whole numbers which are called "quanta."
- Quanta of light are called photons.

- 1905 → Einstein

Things about photons:

- $v = 3E8$ m/s in vacuum
- all have same speed in vacuum
- NO mass
- Yes momentum

$$p = \frac{h}{\lambda}$$

- More equations:

$$E = \frac{hc}{\lambda} = pc$$

$$\text{Power} = nhf \quad n = \text{photons/sec}$$

Atomic Notes and Problem 2.23.12 AP Physics

A 3 mW pen laser radiates at 633 nm. Find values for the following:
a) Frequency of light emitted
b) Energy of a single photon in joules
c) Energy of a photon in electron-volts
d) Momentum of a single photon
e) Number of photons emitted in a quarter-second burst of laser light
f) Length of the beam for quarter-second burst of laser light

a) $c = f\lambda$

$f = 4.74E14\ Hz$

b) $E = hf \quad h = 6.63E{-}34\ J$

$= 3.14E{-}19\ J$

c) $E = hf \quad h = 4.14E{-}15\ eV \cdot s$

$= 1.96\ eV$

d) $p = \frac{h}{\lambda}$

$= 1.05E{-}27\ N \cdot s$

e) $P = nhf$

$n = 9.55E15\ photons/sec$

$Total = n(.25\ s)$

$= 2.39E15\ photons$

f) $c = \frac{distance}{time}$

$distance = 75E6\ m$